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Title of the Invention: MODULE AND MOUNTED STRUCTURE USING THE SAME

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am the translator of the document attached and I state that the following is a true translation to the best of my knowledge and belief of Japanese Patent Application No. 2004-019584 (Date of Application: 28 January 2004).

At Osaka, Japan
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[Name of Document] Specification 1

[Name of Document] Drawings 1

[Name of Document] Abstract 1

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[Document Name] CLAIMS

[Claim 1]

A module comprising;

a plurality of semiconductor packages, each of the plurality of semiconductor packages comprising an LSI chip and a transmission and reception element for conducting a radio communication, constituted independently of the LSI chip;

wherein each of the plurality of semiconductor packages in the module transmits data with each other via a radio communication conducted by the transmission and reception element so as to operate cooperatively.

[Claim 2]

The module according to claim 1, wherein each of the plurality of semiconductor packages comprises the LSI chip, a resin portion for sealing the LSI chip, and the transmission and reception element provided inside or on a surface of the resin portion.

[Claim 3]

The module according to claim 1, wherein each of the plurality of semiconductor packages further comprises an interposer for mounting the LSI chip, and the transmission and reception element is provided inside or on a surface of the interposer.

[Claim 4]

The module according to any one of claims 1 to 3, wherein a shielding layer for blocking electromagnetic waves is provided on a periphery of each of the plurality of semiconductor packages except for a part, and the transmission and reception element conducts a radio communication through the part.

[Claim 5]

The module according to any one of claims 1 to 4, wherein each of the plurality of semiconductor packages is mounted on a wiring board, and each of the plurality of semiconductor packages and the wiring board are electrically connected with each other only through at least one terminal selected from a group consisting of a power source terminal and a ground terminal.

[Claim 6]

The module according to claim 5, wherein the wiring board has a wiring layer formed on one side or both sides thereof.

[Claim 7]

The module according to any one of claims 1 to 4, wherein each of the plurality of semiconductor packages is mounted on a wiring board on which the transmission and reception element for conducting a radio communication is mounted.

[Claim 8]

The module according to any one of claims 1 to 6, wherein each of the plurality of semiconductor packages further comprises a first wiring board and a second wiring board disposed opposite to the first wiring board, and at least one of the plurality of semiconductor packages is mounted on the first wiring board and at least one of the transmission and reception element for conducting radio communication is mounted on the second wiring board.

[Claim 9]

The module according to claim 8, wherein the first wiring board and the second wiring board are electrically connected with each other only through a power source connector.

[Claim 10]

The module according to any one of claims 1 to 9, wherein the transmission and reception element substantially conducts a radio communication in an area within the module.

[Document Name] SPECIFICATION

[Title of the Invention] A MODULE INCLUDING A PLURALITY OF SEMICONDUCTOR PACKAGES

[Field of the Invention]

[0001]

The present invention relates to a module including a plurality of semiconductor packages.

[Prior Art]

[0002]

Accompanying the miniaturization and performance enhancement of electronic equipment in recent years, a larger number of pins are included in a semiconductor element constituting the electronic equipment, and smaller components of various types are used. Accordingly, there has been a dramatic increase in the number and density of wirings in a printed board on which these chips and components are mounted. In particular, the number of leads led out from the semiconductor element and terminals have increased rapidly, thus narrowing the terminal pitch of the semiconductor element and the pitch in wiring patterns of the wiring board (a printed board) on which the semiconductor element is mounted. Under these circumstances, it has become technologically difficult to solder the semiconductor element with a larger number of pins and a narrower terminal pitch. Also, since more layers of finer circuit boards on which the semiconductor elements are mounted are stacked, an increase in the cost of the circuit boards has become apparent.

[0003]

Further, in order to respond to the demand for a higher–density packaging of the electronic components and a higher performance of the

circuit board on which the electronic components are mounted, research and development actively have been conducted on a system–on–chip (SOC) technology that realizes a high–density and high performance packaging using a system LSI by providing a single chip of a semiconductor device with a large number of functions and a system–in–package (SIP) technology that realizes a high–density and high performance packaging constituting a single package of one or more semiconductor chips and a plurality of active components and passive components.

[0004]

Patent document 1 discloses a semiconductor apparatus in which a driving element and a control circuit are incorporated in a single IC (Integrated Circuit) chip in order to miniaturize the semiconductor apparatus (see FIG. 1). Patent document 1 further discloses a semiconductor apparatus that can reduce its mounting area or substrate size without incorporating a driving element and a control element in a single IC chip (see FIG. 2). Hereinafter, these apparatuses will be described with reference to FIGs. 1 and 2.

[0005]

FIG. 1 is a block diagram showing a configuration of an IC chip. As shown in FIG. 1, a plurality of IC chips 112, 113 are mounted on a substrate 111, and the plurality of IC chips 112, 113 are connected to circuit wirings printed on the substrate 11 through connecting schemes 112a, 113a such as a face–down mounting via a wire bonding or a bump. The IC chips 112, 113 are connected to each other through the connecting schemes 112a, 113a and wirings 114.

[0006]

In order to miniaturize the semiconductor apparatus, the IC chips

112, 113 further incorporate driving elements 112c, 113c and control circuits 112b, 113b that control the driving elements 112c, 113c. In a case where a signal is transmitted from the IC chip 112 to the IC chip 113, a value detected by the driving element 112c is converted to a control signal by the control circuit 112b, and the converted control signal is transmitted to the IC chip 113 via the connecting scheme 112a, the wirings 114, and the connecting scheme 113a.

[0007]

In the configuration shown in FIG. 1, the connecting schemes 112a, 113a and the wiring 114 commonly used are provided between the IC chip 112 and the IC chip 113, and thus the mounting area and substrate size in the semiconductor apparatus become larger. Also, in the configuration shown in FIG. 1, heat generated from the driving elements 112c, 113c propagate to the control circuits 112b, 113b, which may induce the degradation of performances in the control circuits 112b, 113b.

[0008]

In order to avoid these problems, in the configuration as shown in FIG. 2, a driving IC chip 202 on which a transmission and reception antenna 202a is provided and a controlling IC chip 203 on which a transmission and reception antenna 203a is provided are mounted on a substrate 201 separately.

[0009]

The driving IC chip 202 includes a driving element 202c, an RF circuit connected to the transmission–reception antenna 202a, a control signal detection circuit for detecting a signal for driving the driving element 202c by a signal demodulated by the RF circuit 202b and an anomaly detection circuit for detecting an anomaly when an anomaly occurs in the

driving element 202c. On the other hand, the controlling IC chip 203 includes a control circuit 203c for controlling the driving element 202c incorporated in the IC chip 202 and an RF circuit 203b connected to the transmission–reception antenna 203a.

[0010]

In accordance with the configuration shown in FIG. 2, a signal between the IC chip 202 and the IC chip 203 is transmitted via the transmission–reception antennas 202a and 203a, so that the signal can be transmitted by radio waves between the IC chips. This makes it possible to omit wirings or the like provided on a substrate for forming a transmission path between the IC chips, allowing the decrease in the mounting area and substrate size of the semiconductor apparatus and the miniaturization of the entire semiconductor apparatus. Furthermore, the driving element 202c and the control circuit 303c are incorporated into different IC chips, thereby preventing heat generated from the driving element 202c from propagating to the control circuit 203c, so that the performance of the control circuit 203c can be prevented from deteriorating.

[Patent document 1] JP 2003–218315 A

[Disclosure of the Invention]

[Problems to be Solved by the Invention]

[0011]

However, the configuration shown in FIG. 2 has problems as described below.

[0012]

First of all, a single IC chip (112 or 113) is used in the configuration shown in FIG. 1, however, this single IC chip corresponds to two IC chips 202, 203 in the configuration shown in FIG. 2, which has an opposite effect

of requiring a larger mounting area and substrate size to the semiconductor apparatus. Therefore, the miniaturization of the entire semiconductor apparatus is extremely difficult.

[0013]

Moreover, the control circuit 112b (or 113b) and the driving element 112c (or 113c) in the configuration shown in FIG. 1 that are integrated to a single IC chip (so–called system LSI chip) can form, when it is divided, two IC chips as in the configuration shown in FIG. 2. Then, each of the chips (202, 203) itself forms a system LSI chip including a plurality of functioning blocks, which results in the IC chips 202, 203 with a significantly high manufacturing cost.

[0014]

In addition, by separately disposing the driving element 202c and the controlling element 203c, the influential propagation of heat is eliminated. In stead, since the RF circuits (202b, 303b) are disposed adjacent, the noise due to electromagnetic waves has a greater influence on the driving element 202c and the control circuit 203c. Even if the anomaly detection circuit could detect the anomaly as being influenced by the noise due to electromagnetic waves, the semiconductor apparatus still cannot execute a normal operation while the anomaly lasts.

[0015]

The present invention has been conceived in view of the above–mentioned matters. The main object thereof to provide a module that includes a plurality of semiconductor packages and allows the reduction of the number of wirings while being suitable for the miniaturization.

[Means for Solving the Problems]

[0016]

A module according to the present invention includes a plurality of semiconductor packages, each of the plurality of semiconductor packages including an LSI chip and a transmission and reception element for conducting radio communication, constituted independently of the LSI chip. Each of the plurality of semiconductor packages in the module transmits data with each other via a radio communication conducted by the transmission and reception element so as to operate cooperatively.

[0017]

In a preferable embodiment, each of the plurality of semiconductor packages is constituted by the LSI chip, a resin portion for sealing the LSI chip, and the transmission and reception element provided inside or on a surface of the resin portion.

[0018]

In a preferable embodiment, each of the plurality of semiconductor packages further includes an interposer for mounting an LSI chip, and the transmission and reception element is provided inside or on a surface of the interposer.

[0019]

In a preferable embodiment, a shielding layer for blocking electromagnetic waves is provided on a periphery of each of the plurality of semiconductor packages except for a part, and the transmission and reception element conducts a radio communication through the part.

[0020]

In a preferable embodiment, each of the plurality of semiconductor packages is mounted on a wiring board, and each of the plurality of

semiconductor packages and the wiring board are electrically connected with each other only through at least one terminal selected from a group consisting of a power source terminal and a ground terminal.

[0021]

In a preferable embodiment, the wiring board has a wiring layer formed on one side or both sides thereof.

[0022]

In a preferable embodiment, each of the semiconductor packages is mounted on a wiring board on which the transmission and reception element for conducting radio communication is mounted.

[0023]

In a preferable embodiment, each of the plurality of semiconductor packages further includes a first wiring board and a second wiring board disposed opposite to the first wiring board, and at least one of the plurality of semiconductor packages is mounted on the first wiring board and at least one of the transmission and reception element for conducting radio communication is mounted on the second wiring board.

[0024]

In a preferable embodiment, the first wiring board and the second wiring board are electrically connected with each other only by a power source connector.

[0025]

In a preferable embodiment, the transmission and reception element substantially conducts a radio communication in an area within the module.

[The Effect of the Invention]

[0026]

In accordance with a module of the present invention that includes a

plurality of semiconductor packages, each of the semiconductor packages includes an LSI chip and a transmission and reception element for conducting a radio communication, constituted independently of the LSI chip, and the transmission and reception elements transmit data with each other via radio communication so as to operate cooperatively. Accordingly, a module that allows the reduction of the number of the wirings while being suitable for the miniaturization is realized. Furthermore, it would not be necessary to use an unduly high clock frequency, thereby realizing the operation with stability and high–speed.

[Best Modes for Carrying Out the Invention]

[0027]

Along with the high–speed operation of an LSI chip using high frequency notable in recent years, the amount of information to be processed has been growing. In addition, there is also a demand for the miniaturization of electronic equipments, making semiconductor elements to further achieve the reduction in size and increase in the number of pins and thus, the number of wirings and density of wiring boards that mount such semiconductors increase. Under these circumstances, the inventors of the present invention considered that the wirings of wiring boards are attributable to various problems and determined the use of a module in which wirings of wiring boards are substantially removed so that a plurality of semiconductor packages are mounted on a wireless wiring board. The inventors then conceived of the potentiality of a wireless configuration for transmission and exchange of information without forming the wirings around to process signals. As an existing wireless configuration, one disclosed in FIG. 2 has a wireless configuration, however, it is not suitable for the miniaturization as described above. Moreover, it has a problem of

the high manufacturing cost or the like. Consequently, the inventors of the present invention began an extensive study on building of a module having a wireless configuration and a simple–structure to be suitable for the reduction in size, and came up with the present invention.

[0028]

Hereinafter, embodiments of the present invention will be described with reference to the drawings. In the following drawings, constituent elements having substantially the same functions are indicated by the same reference numbers to simplify the description thereof. It should be noted that the present invention is not limited to the following embodiments.

[0029]

With reference to FIGs. 3 and 4, a module 100 including a plurality of semiconductor packages 50 according to an embodiment of the present invention is described. FIG. 3 schematically shows a cross–sectional configuration of the module 100 of this embodiment and FIG. 4 schematically shows a planar configuration of the semiconductor package 50.

[0030]

The module 100 of the present embodiment includes a plurality of semiconductor packages 50. Each of the semiconductor packages 50 is configured by an LSI chip or a part 10 which includes the LSI chip and a transmission and reception element 20 that conducts a radio communication 25. The transmission and reception element 20 of the present embodiment is a so–called RF module consisted independently of the LSI chip. In the module 100 of the present embodiment, each of the semiconductor packages 50 transmits data with each other via the ratio communication 25 by the transmission and reception element 20 so as to operate cooperatively. As

shown in FIG. 3, each of the semiconductor packages 50 is mounted on a wiring board 30 through a connecting terminal 18.

[0031]

According to the configuration of the present embodiment, the plurality of packages 50 constituting the module 100 transmit data with each other via the radio communication 25 by the transmission and reception element 20 so as to operate cooperatively, so that it is possible to considerably decrease the number of the terminals 18 to be provided on the semiconductor package 50. In other words, a signal to be input and output to the semiconductor package 50 can be transmitted partly or entirely, not through the wiring board 30, but through the radio communication 25 by the transmission and reception element 20. Accordingly, a large number of signal terminals which have been disposed on the semiconductor package 50 can be reduced considerably.

[0032]

Due to the decrease in the number of the terminal 18 of the semiconductor 50, the terminals 18 can be widely spaced with each other even for those that have been subjected to the electrical connection with narrow pitches. Therefore, the semiconductor package 50 can be mounted on the wiring board 30 with great ease. Consequently, a yield in the manufacturing process of the module 100 is increased, thereby realizing a lower manufacturing cost.

[0033]

In a presumable case where extremely fine wiring patterns are formed on the wiring board 30, along with the increase in circuit size and speed notable in LSI chips of the recent years, it has become more difficult to operate LSI chips by using such a fine wiring pattern. A fan–out of the

wirings to stabilize the operation of the LSI chip may result in even larger apparatus (module). Since the module 100 of the present embodiment utilizes the radio communication 25 by the transmission and reception element 20, a problem like this can be avoided.

[0034]

Furthermore, since the number of the terminals 18 of the semiconductor packages 50 are reduced, it is possible that the mounting with respect to semiconductor packages 50 can be done by using a single-sided substrate or a double-sided substrate of lower cost, without applying an expensive multilayered substrate for the wiring board 30. In addition, the soldering of semiconductor elements having an increasing number of pins and narrower pitches has recently become technologically difficult. However, in the configuration of the present embodiment, the semiconductor package 50 has the terminals 18 in small number and with wide pitches, so that the technological difficulty with the soldering is significantly moderated. The use of less amount of solder also results in employing an environmentally friendly manner.

[0035]

Moreover, in the configuration of the present embodiment, the transmission and reception element (RF module) 20 is configured independently of the LSI chip, allowing a considerable cost reduction compared with the case where a transmission and reception circuit is formed on a part of an internal circuit of an LSI chip. In other words, the transmission and reception element 20 can be used as a chip independent of the LSI chip (RF module), so that the transmission and reception element 20 of low cost can be utilized. At the same time, since no design change with respect to an internal circuit of each of LSI chips to incorporate

transmission and reception circuits is necessary, the module 100 can be built at low cost.

[0036]

It also is advantageous in that the influence of noise which the inner circuit of an LSI chip suffers from the radio communication 25 of the transmission and reception element 20 is reduced by providing the transmission and reception element 20 and the LSI chip independent of one another, as compared with the case where the transmission and reception circuit is incorporated as a part in the internal circuit of the LSI chip.

[0037]

In the configuration as shown in FIGs. 3 and 4, the LSI chip is sealed with resin and thus, the part 10 including the LSI chip is constituted of the LSI chip and the resin portion that seals the LSI chip. The transmission and reception element (RF module) 20 is disposed on a surface of the resin portion. With this configuration, one can make use of both a typical resin molded LSI chip component 10 and an RF module 20, thereby lowering the cost of the module 100. Furthermore, since a large number of electronic components are commonly used, the transmission and reception element (RF module) 20 becomes applicable to the standard specification approved by individual firms and organizations, which may enhance the effect of further cost reduction. In the present embodiment, the RF module 20 is electrically connected to a resin molded LSI chip and is connected, for example, by means of soldering over the part 10 including LSI chip in a face-down manner.

[0038]

The semiconductor package 50 is mounted on the wiring board 30 through the connecting terminals 18 each of which may be constituted only

by a power source terminal 18s and a ground terminal 18g (four terminals at maximum). Since the configuration according to the present embodiment allows the transmission and reception element 20 to transmit data with each other via the radio communication 25, the data transmission is possible without providing the connecting terminals 18 as signal terminals, thereby utilizing the power source terminal 18s and the ground terminal 18g. Therefore, in accordance with the configuration of the present embodiment, a wireless connecting module (Wireless Network Module) that makes use of the transmission and reception terminal 20 can be built.

[0039]

The connecting terminals 18 are, for example, solder balls and a wiring pattern (for example, land) is formed on a portion of the wiring board 30 where the wiring terminals 18 are in contact therewith. The connecting terminals 18 also can be pins. It is also possible that a terminal specific to signals or a terminal specific to examination can be provided as the connecting terminals 18 other than the power source terminal 18s and the ground terminal 18g.

[0040]

In the present embodiment, the wiring board 30 uses a wiring board (single-sided substrate) forming a wiring layer on one side thereof. As described above, the semiconductor package 50 can conduct the radio communication 25 by the transmission and reception element 20, so that the number of terminals of the semiconductor package 50 can be reduced considerably. Thus, the packaging of the semiconductor package 50 can be carried out satisfactorily using a cheap single-sided substrate without the use of an expensive multilayered substrate. Furthermore, in terms of an

inexpensive wiring board, a double-sided substrate may also be utilized.

[0041]

In order to make the transmission and reception element 20 to transmit data with each other via the radio communication 25 so as to make the semiconductor packages 50 to operate cooperatively, for example, the transmission and process of data from a circuit A in each of the semiconductor packages 50 to a circuit B in another of the semiconductor packages 50 is possible. Conventionally, other circuits were in a standby state during this operation. However, in the module of the present invention, the other circuits should not be in the standby state, enabling the other circuits to operate at the same time by taking advantage of the radio communication by the transmission and reception element.

[0042]

Moreover, while a data transmission through metal wirings of the wiring board 30 is carried out about 200 MHz at maximum, a data transmission 25 through the transmission and reception element 20 of the present embodiment can achieve, for example, at least 1000 MHz (e.g., about 1 to 10 GHz).

[0043]

It is noted that, in terms of circuits, there is essentially no significant difference between the building ways of a certain functional circuit; by making the semiconductor packages 50 connected with each other by means of wirings to operate cooperatively and; as in the present embodiment, by making the semiconductor packages 50 to operate cooperatively via radio communication. In the case of using the radio communication 25, since there is no limitation in designing the wiring board 30, a high degree of freedom in design can be achieved, making it easier to

produce even smaller module 100.

[0044]

An example of a detailed configuration of the present embodiment is described as follows. An LSI chip, a rectangle in shape, has sides of 2 to 15 mm and has a thickness of, for example, 0.1 to 0.5 mm. A molding portion for molding an LSI chip (i.e., a part 10 including the LSI chip), a rectangle in shape, has sides of 3 to 20 mm and has a thickness of, for example, 0.3 to 1.0 mm. It is possible that, as an LSI chip, the one with a known typical configuration is used. A transmission and reception element 20 is an RF module, a rectangle in shape, having sides of 2 to 4 mm and a thickness of, for example, 0.1 to 0.5 mm. It is possible that, as the transmission and reception element 20 of the present embodiment, the one with a known typical configuration is used. It is preferable that an antenna is connected to each of the transmission and reception element 20, and the antenna can be obtained, for example, by means of the wiring patterns formed on a substrate.

[0045]

In the semiconductor package 50 in the module 100 of the present embodiment, the transmission and reception element 20 can be provided inside the resin portion 14 for sealing the LSI chip 12, as shown in FIG. 5.

[0046]

In an example shown in FIG. 5, the semiconductor package 50 has a stacked configuration in which the LSI chips (or the IC chips) 12 are stacked in two-tier, in which the transmission and reception element 20 is mounted on the upper tier of the LSI chip 12, so that the transmission and reception element 20 is electrically connected to the LSI chip 12 of the upper tier. The LSI chip of the upper tier is electrically connected to an interposer

(intermediate substrate) 19 by means of a bonding wire 13, while the LSI chip 12 of the lower tier is electrically connected to the interposer 19 by means of a connecting terminal (for example, a bump, a solder ball) 15. The upper and lower LSI chips are electrically connected with each other through the interposer 19. Incidentally, a two–tiered configuration of the LSI chips 12 is alternative, and a semiconductor package 50 including single LSI chip 12 is possible.

[0047]

The semiconductor package 50 as shown in FIG. 5 can be used in plural to operate cooperatively by conducting a data transmission between the transmission and reception elements 20 via radio communication 25. Also, the semiconductor packages 50 shown in FIGs. 3 and 4 can be combined with the semiconductor package 50 shown in FIG. 5 so as to built a module 100 according to the present embodiment.

[0048]

Furthermore, as shown in FIG. 6(a) and 6(b), the semiconductor package 50 of the present embodiment can be obtained by incorporating the transmission and reception element 20 into the interposer 19 and then, mounting the LSI chip 12 (or a part 10 including the LSI chip) on the interposer 19. The incorporation of the transmission and reception element 20 into the interposer 19 allows the mounting area on the interposer 19 to be utilized effectively. In addition, when the interposer 19 incorporating the transmission and reception element 20 is used, the semiconductor package 50 capable of conducting radio communication can be built just by mounting the LSI chip 12 on the interposer 19. Thus, it would be more convenient to built the semiconductor package 50 compared with the way in which each of the LSI chip 12 is mounted on the transmission and reception

element 20 one by one.

[0049]

To incorporate the transmission and reception element 20 into the interposer 19A, a technique for producing substrates with embedded components (for example, SIMPACT™) may be used. The LSI chip 12 on the interposer 19 is electrically connected with the interposer 19 through a connecting terminal 15, and is further connected electrically to the transmission and reception element 20 through wirings or a via inside the interposer 19. A position of the interposer where the transmission and reception element 20 is incorporated is not limited to the center, and it is possible to dispose at a portion where the transmission and reception element 20 included in the adjacent semiconductor package 50 is near. In addition, although the transmission and reception element 20 is incorporated into the interposer 19 in the configurations shown in FIGs. 6(a) and (b), the transmission and reception element 20 can be disposed on a surface of the interposer 19.

[0050]

In a module 100 of the present embodiment, it is possible that the radio communication 25 for inputting and outputting with respect to the semiconductor package 50 has a directivity. This can be achieve, for example, by providing a shielding layer for blocking electromagnetic waves on a periphery of the semiconductor package 50 except for a part, so as to make the transmission and reception element 20 to conduct the radio communication 25 through the part.

[0051]

In a configuration shown in FIG. 7, a shielding layer 40 for blocking electromagnetic waves is formed on a side of the semiconductor package 50

(more specifically, the interposer 19) as shown in FIG. 6(b) and, the transmission and reception element 20 conducts the radio communication 25 through the part 41 without the shielding layer 40. The shielding layer 40 is, for example, a metal layer (for example, a foil formed of cupper or nickel or the like, or a plating layer) For the materials for forming the shielding layer 40, other than metals (Cu, Al, Ni, etc.), magnetic materials (ferrite, etc.) and resins in which metals or magnetic materials or the like are dispersed may be used as long as they are electromagnetic wave preventive materials. This shielding layer 40 not only allows electromagnetic waves for inputting and outputting with respect to the semiconductor package 50 to have the directivity, but also can device a countermeasure to noise from the LSI chip 12. In other words, owing to the shielding function of the shielding layer 40, the noise can be reduced. It is possible that the shielding layer 40 is formed on an upper and/or a lower surface as well as a side surface of the interposer 19.

[0052]

The configuration provided with the shielding layer 40 is realized in a configuration shown in FIG. 7 and also can be realized as shown in FIG. 8. The configuration shown in FIG. 8 is obtained by using the transmission and reception element 20 included in the semiconductor package 50 shown in FIG. 4 to which the shielding layer 40 is formed, thereby providing the directivity. In an example shown in FIG. 8, the shielding layer 40 is formed entirely except for the part 41.

[0053]

The transmission and reception element 20 in the semiconductor package 50 is qualified as long as it is capable of conducting the radio communication 25 with the other transmission and reception element 20

within the module 100. Therefore, it is preferable to use the transmission and reception element 20 capable of generating electromagnetic waves at a low output, which allows the electromagnetic waves to reach the other transmission and reception element 20 at a distance within a range of at least 20 mm. By using the transmission and reception element 20 as such, the radio communication 25 can be conducted substantially within an area of the module 100. At the same time, the electrical power of the semiconductor package 50 or the module 100 can be saved. Furthermore, the problem with respect to noise from inside and outside of the module 100 can be alleviated. In addition, it is preferable to form the shielding layer 40 on a surface or periphery of the module 100 so as to prevent electromagnetic waves from the transmission and reception element 20 to leak out of the module 100.

[0054]

It should be noted that the radio communication 25 used between the semiconductor packages 50 in the module 100 according to the present embodiment and a radio communication (for example, a radio LAN, Bluetooth, etc.) used in information communication equipment (for example, a notebook computer, a desk-top computer, a mobile phone, etc.) are essentially different. The reason is that such a radio communication conducted in information communication equipment merely receives information from an external part of the equipment or transmits information from an internal part of the equipment and does not make each of the semiconductor packages to operate cooperatively. It of course is possible, in a information communication equipment including the module 100 according to the present embodiment, to achieve by providing an additional radio communication part a configuration that allows the use of

the radio communication 25 between the semiconductor packages 50 within the module 100 and the radio communication for connecting the internal and external parts of the information communication equipment. In this case, a surface or periphery of the module 100 can be blocked with the shielding layer 40, however, it is not preferable to block the information communication equipment itself entirely because, by doing so, the information communication equipment would not be able to conduct any radio communication.

[0055]

Moreover, since the module 100 of the present embodiment achieves the connection between the semiconductor packages 50 via the radio communication 25, if the semiconductor package 50 can be supplied with the electrical power, the operational test of the module 100 can be carried out without mounting each of the semiconductor packages 50 on the wiring board 30, which would be a new advantage. This means that an examination of the module 100 can be accomplished by a method different from the conventional method.

[0056]

Even when the defective operation is observed as a result of the examination, each of the semiconductor package 50 can be highly repairable and thus convenient, if it is not mounted on the wiring board 30 or is mounted as easily repairable. In addition, when the operational test is carried out with respect to trial products, besides the examination of finished products, the configuration of the module 100 of the present embodiment is excellent in its convenience.

[0057]

Although the present embodiment achieves the connection with each

other in a plurality of semiconductor packages 50 via the radio communication 25, it is not limited thereto and modifications are possible.

[0058]

In FIG. 9, it is possible that the transmission and reception element 20 is mounted on a part of the wiring board 30, thereby connecting the transmission and reception element 20 of the semiconductor package 50 and a transmission and reception element 20' on the wiring board 30 via the radio communication 25. Accordingly, the connection can be achieved not only between the semiconductor packages 50 but also between the semiconductor package 50 and the wiring board 30 via the radio communication 25. This means that, in a case where an electronic component (for example, a semiconductor element) is mounted on the wiring board 30, once an electrical connection is achieved between this electronic component and the transmission and reception element 20' on the wiring board, further connection can be achieved between the electronic component and the LSI chip 12 within the semiconductor package 50.

[0059]

In addition, as shown in FIG. 10, the connection between the substrates is achieved through the radio communication 25 by the transmission and reception element 20.

[0060]

The module 100 as shown in FIG. 10 has, other than the wiring board 30, another wiring board (child board) 32 to which the LSI chip 12 and the transmission and reception element 20 are mounted so as to build the semiconductor package 50. On the wiring board 32, electronic component (for example, a passive component) 22 is further mounted. Still more, the transmission and reception element 20' is mounted on the wiring

board 30 as well. The transmission and reception element 20' and the transmission and reception element 20 on the wiring board 32 transmit data with each other via the radio communication 25, so that the connection between the wiring board 30 and the wiring board 32 is achieved. In this case, the LSI chip 12 may be a semiconductor element (for example, a CSP (chip-size-package)) including the LSI chip 12.

[0061]

The signal transmission between the wiring board 30 and the wiring board 32 can be conducted via the radio communication 25 and thus, in the configuration shown in FIG. 10, the wiring board 30 and the wiring board 32 can be electrically connected with each other only through a power source connector 34. In other words, it is possible to omit any connection (wiring or via) for a signal between the wiring board 30 and the wiring board 32, and by supplying an electrical power to the wiring board 32 through the power source connector 34, the signal transmission between the wiring board 30 and the wiring board 32 is realized.

[0062]

According to a typical technology for connecting substrates, when the wiring board 30 and the wiring board 32 are connected, connectors are often utilized to mechanically connect them. However, since the connectors are large in size, their low space availability was a contributing factor to hinder the miniaturization to be attained. Moreover, if the LSI chip 12 operable in high speed and high frequency is mounted on the wiring board 32, it was difficult, by using of the typical connection method, to effectively transmit the operation of the LSI chip 12 in high speed and high frequency. In contrast, by making use of a connection method for the substrates according to the present embodiment, the wiring board 30 and the wiring

board 32 can be connected via the radio communication 25, facilitating the miniaturization and allowing the operation of the LSI chip 12 in high speed and high frequency to be transmitted effectively.

[0063]

In an example shown in FIG. 10, the transmission and reception element 20' is disposed on the wiring board 30. However, it is of course possible that the semiconductor package 50 including the transmission and reception element 20' is mounted on the wiring board 30 so as to conduct the radio communication 25 between the transmission and reception element 20' and the transmission and reception element 20.

[0064]

Moreover, although a configuration shown in FIG. 10 exemplifies the wiring board 30 and the wiring board 32 that are provided as opposed to each other, it is not always necessary that the wiring boards are provided as opposed to each other. As long as the radio communication 25 is available between the transmission and reception element 20 and the transmission and reception element 20', it is possible to achieve a connection between the wiring board 30 and the wiring board 32 via the radio communication 25 even these wiring boards are located where the wiring connection is physically difficult.

[0065]

FIG. 11 schematically shows each of substrates (each of functional modules) in a case where the module 100 according to the present embodiment is built as an information communication equipment. The configuration shown in FIG. 11 includes, for example, a key pad (an input means) 62, an LCD unit (a display means) 64, a logic module (a controlling means) 66, and an RF module (an external communication means) 68, and

to each of which the semiconductor package 50 of the present embodiment is attached. Each of the functioning modules (62, 64, 66, 68) is attached with the semiconductor package 50, so that the semiconductor package 50 can conduct data transmission with each other via the radio communication 25 by the transmission and reception element 20 included in each of the semiconductor packages 50 and thus operate cooperatively.

[0066]

In a case where an information communication equipment (a mobile phone, in this case) 101 as shown in FIG. 12 is mounted with each of functioning modules (62, 64, 66, 68), a first body portion 60 on which a key pad 62 is disposed and a second body portion 61 on which an LCD unit 64 is disposed has a movable portion (a hinge portion, in this case) 70 therebetween, so that there have been various constraints on the physical connection with wirings between the key pad 62 and the LCD unit 64. Therefore, primarily, the degree of freedom in design has been fairly restricted. In contrast, according to a configuration of the present embodiment, the radio communication 25 by the semiconductor packages 50 allows a connection between the key pad 62 and the LCD unit 64, so that a high degree of freedom in design is ensured unlike in the conventional case. It is of course not necessary to connect all of the functioning modules (62, 64, 66, 68) via the radio communication 25. A connection can be achieved via the radio communication 25 between the key pad 62 and the LCD unit 64, and an electrical connection is then achieved further between any or all of the key pad 62 mounted on the first body portion 60, the LCD unit 64, the logic module 66, and the RF module 68.

[0067]

FIG. 13 schematically shows a configuration of a notebook computer

102 as an example of an information communication equipment. In this notebook computer 102, the RF module 68 is not mounted. The configuration as shown in FIG. 13 also has a movable portion 70 between the first body portion 60 on which the key pad 62 is disposed and the second body portion 61 on which the LCD unit 64 is disposed, making the radio communication 25 advantageous in connecting the key pad 62 and the LCD unit 64. Moreover, if a power source can be divided, each of the units (the key pad 62 and the LCD unit 64, etc.) may be disposed apart from each other. In addition, in examples shown in FIGs. 11 to 13, the LCD unit 64 used as a display means can be other display apparatuses (for example, an organic EL (Electroluminescence) unit), and alternatively, mount other functioning modules such as storing devices (for example, a volatile memory or an involatile memory).

[0068]

With a configuration of an embodiment of the present embodiment, it is possible that a module can be built that allows the reduction of the number of wirings while being suitable for the miniaturization. It is also possible to realize a simple and small module which can transmit and exchange information without the wirings formed around. Consequently, the following advantages can be attained, i.e., no interconnecting wiring, miniaturization, mounting on a limited space, high reliability attributable to the limited connection, availability of inexpensive substrates, high connectability with the movable portion, etc.

[0069]

The preferable embodiments of the present invention are described above. It should be noted that the description is not limited thereto and of course various modifications are possible.

[Industrial Applicability]

[0070]

According to the present invention, a module including a plurality of semiconductor packages can be provided that allows the reduction of the number of wirings while being suitable for the miniaturization,.

[Brief Description of the Drawings]

[0071]

[FIG. 1] A block diagram showing a configuration of a conventional IC chip.

[FIG. 2] A block diagram showing a configuration of a conventional IC chip.

[FIG. 3] A sectional view schematically showing a configuration of a module 100 including a plurality of semiconductor packages 50 according to an embodiment of the present invention.

[FIG. 4] A plan view schematically showing an example of the semiconductor package 50.

[FIG. 5] A sectional view schematically showing an example of the semiconductor package 50.

[FIG. 6] (a) and (b) are a sectional view and a plan view schematically showing an example of the semiconductor packages 50, respectively.

[FIG. 7] A sectional view schematically showing an example of the semiconductor package 50.

[FIG. 8] A sectional view schematically showing an example of the semiconductor package 50.

[FIG. 9] A sectional view schematically showing an example of the semiconductor package 50.

[FIG. 10] A sectional view schematically showing a configuration of a module 100 according to an embodiment of the present invention.

[FIG. 11] A view schematically showing each of substrates (each of functioning modules) in a case where a module 100 according to an embodiment of the present invention is built as an information communication equipment.

[FIG. 12] A perspective view schematically showing a configuration of a mobile phone 101 according to an embodiment of the present invention.

[FIG. 13] A perspective view schematically showing a configuration of a notebook computer 102 according to an embodiment of the present invention.

[Description of the Reference Numerals]

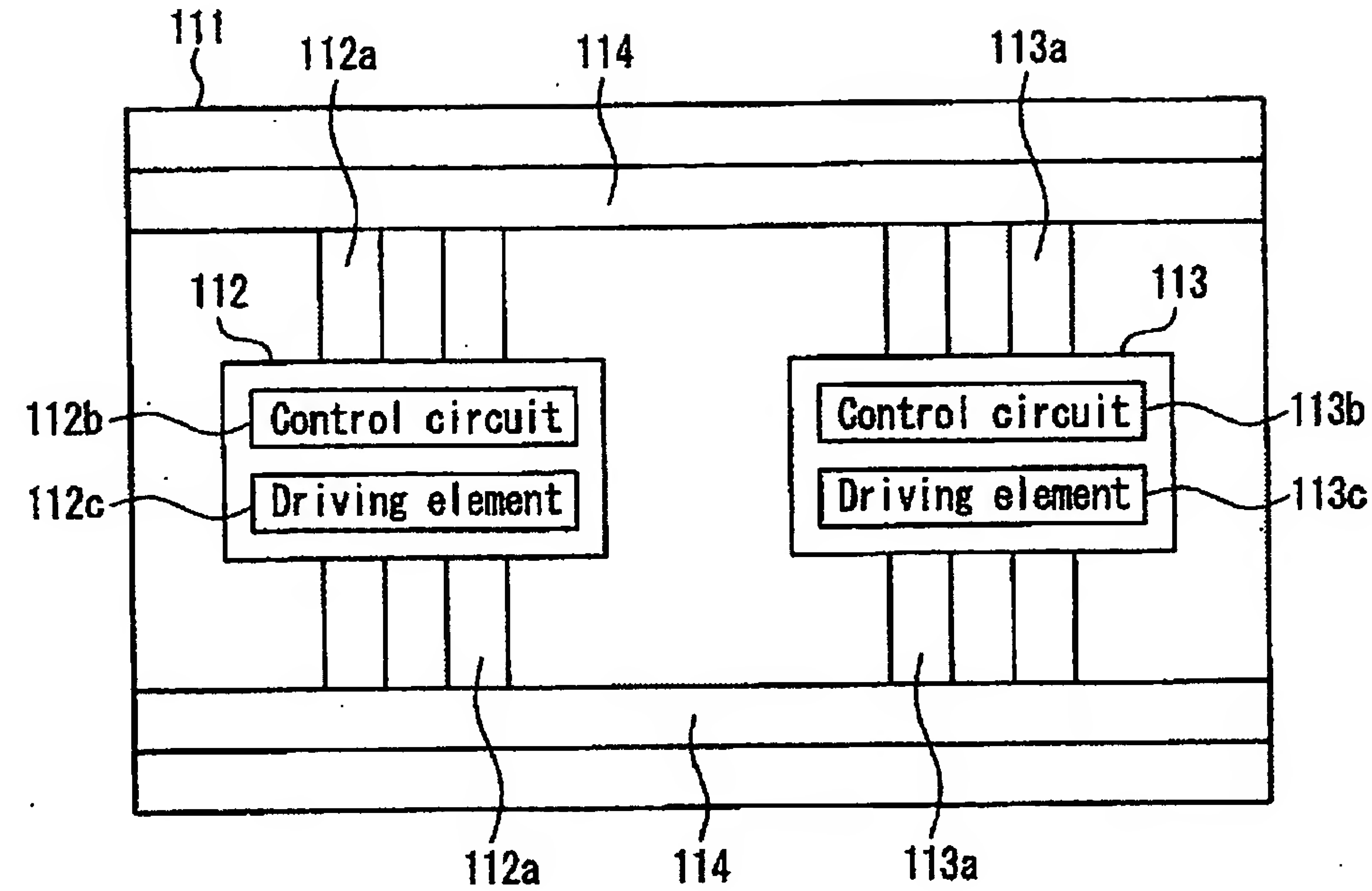
[0072]

10	part including an LSI chip
11	substrate
12	LSI chip
13	bonding wire
14	resin portion
15	connecting terminal
18	connecting terminal
18g	ground terminal
18s	power source terminal
19	interposer
20	transmission and reception element
25	radio communication
30	wiring board
32	wiring board

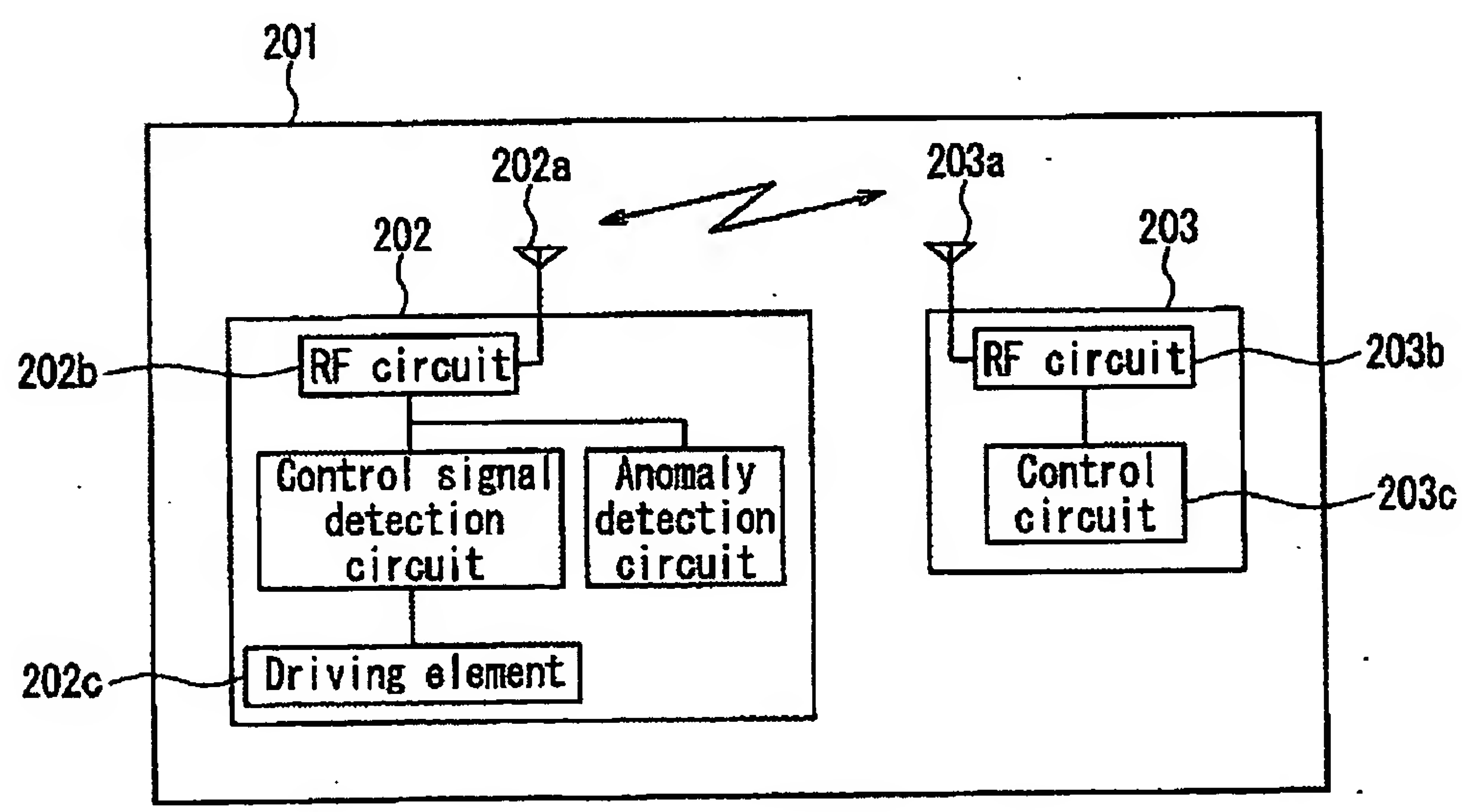
34	power source connector
40	shielding layer
50	semiconductor package
60	body portion
61	body portion
62	key pad
64	LCD unit
66	logic module
68	RF module
70	movable portion
100	module
101	mobile phone
102	notebook computer

[Document Name] Drawings

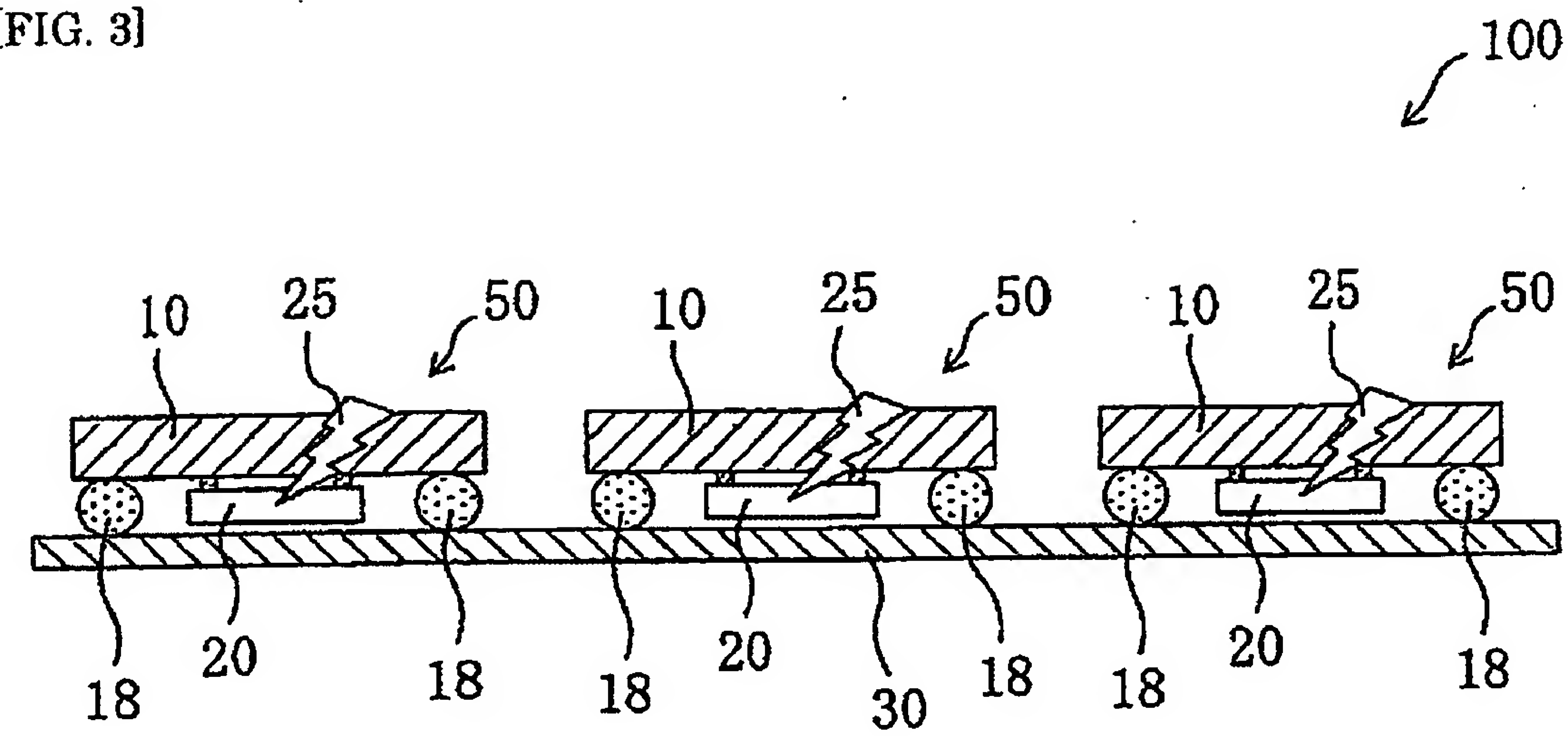
[FIG. 1]



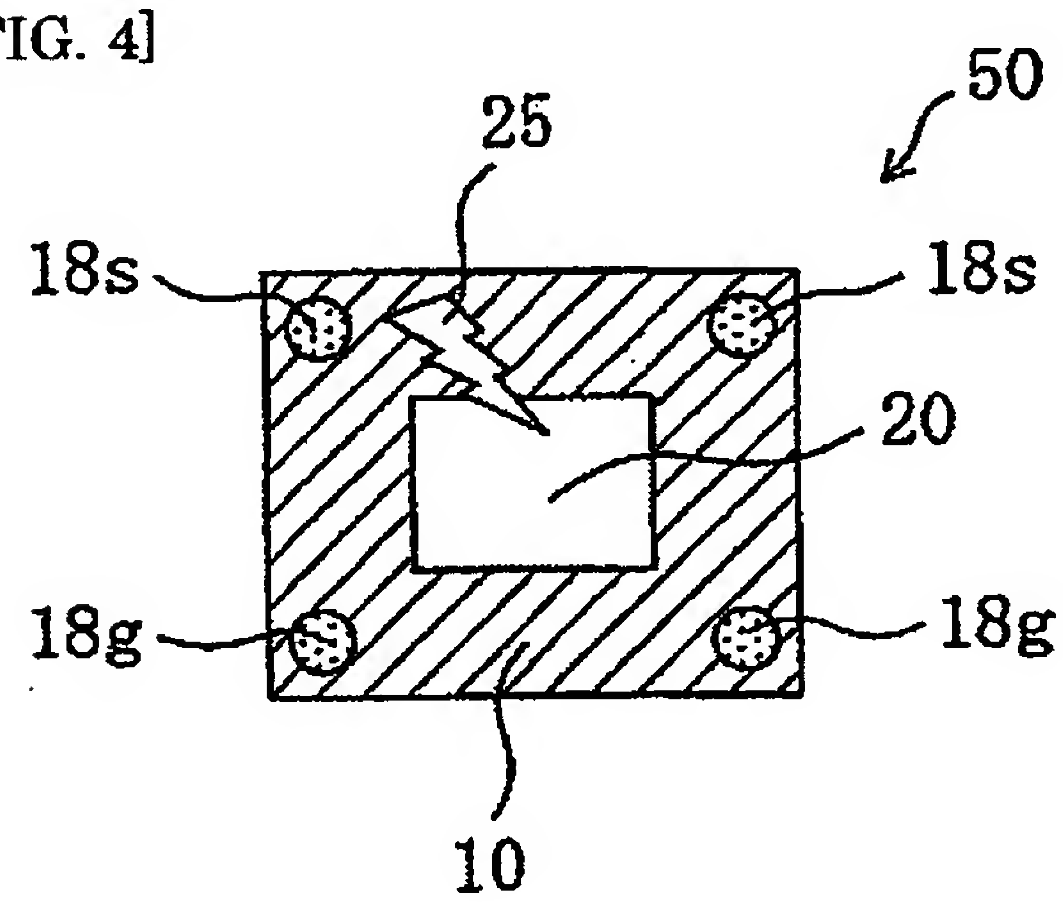
[FIG. 2]



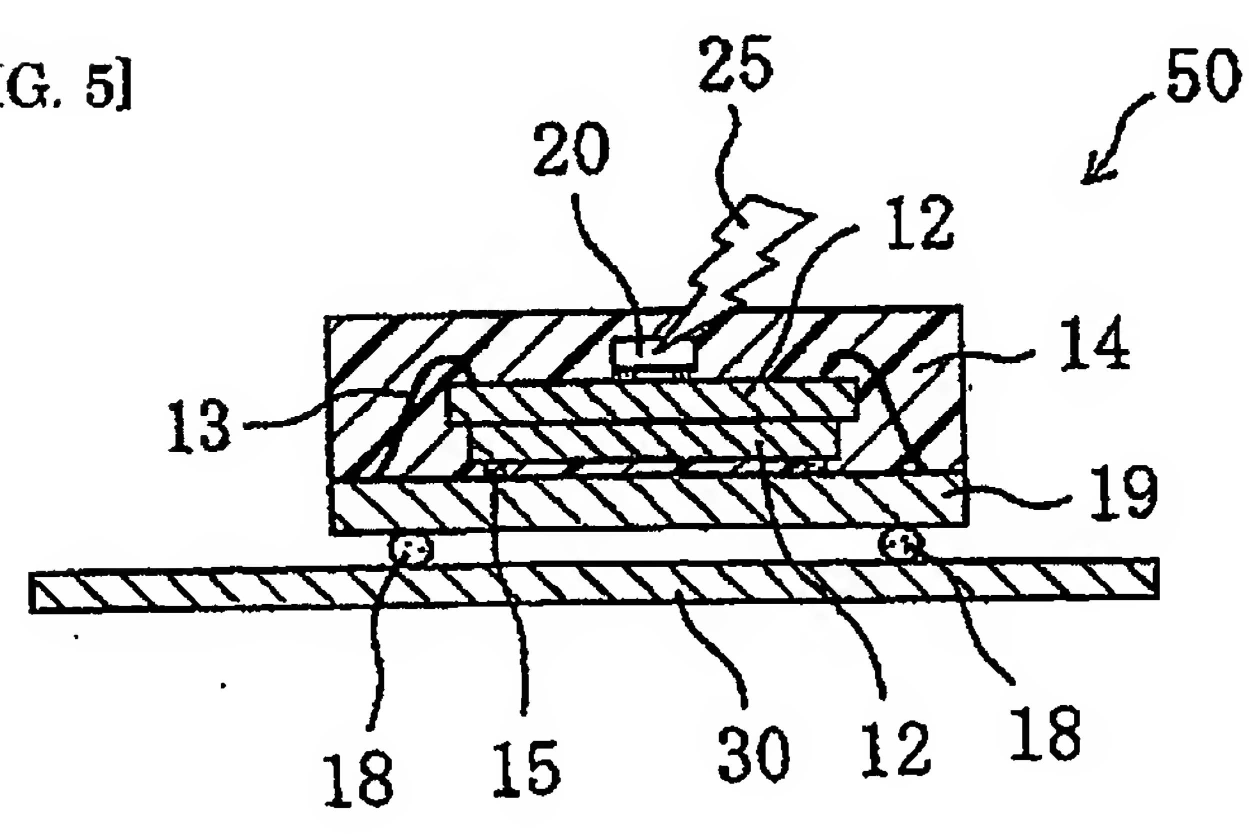
[FIG. 3]



[FIG. 4]

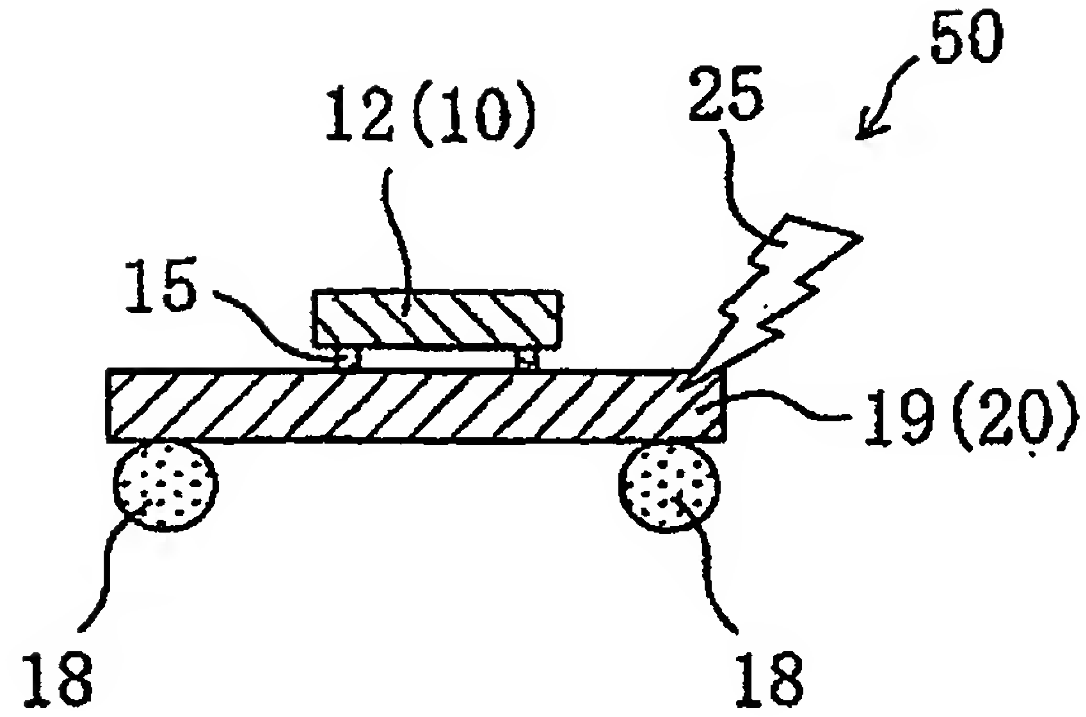


[FIG. 5]

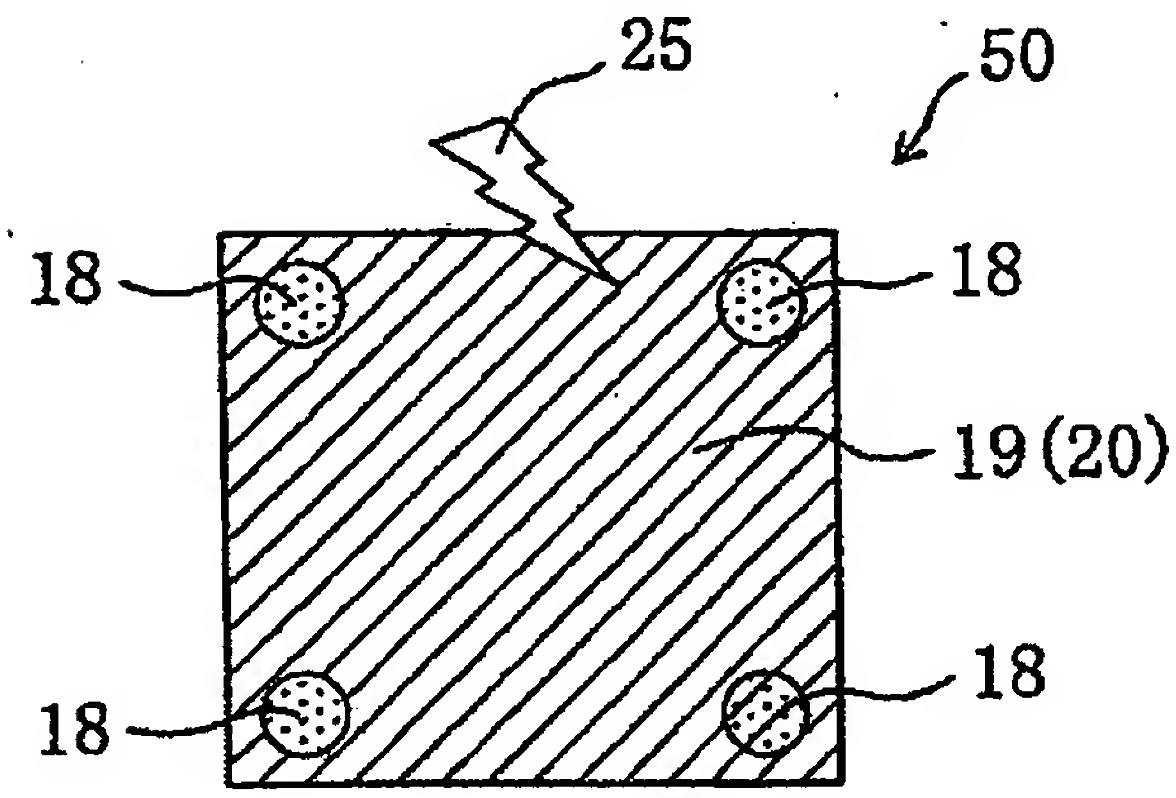


[FIG. 6]

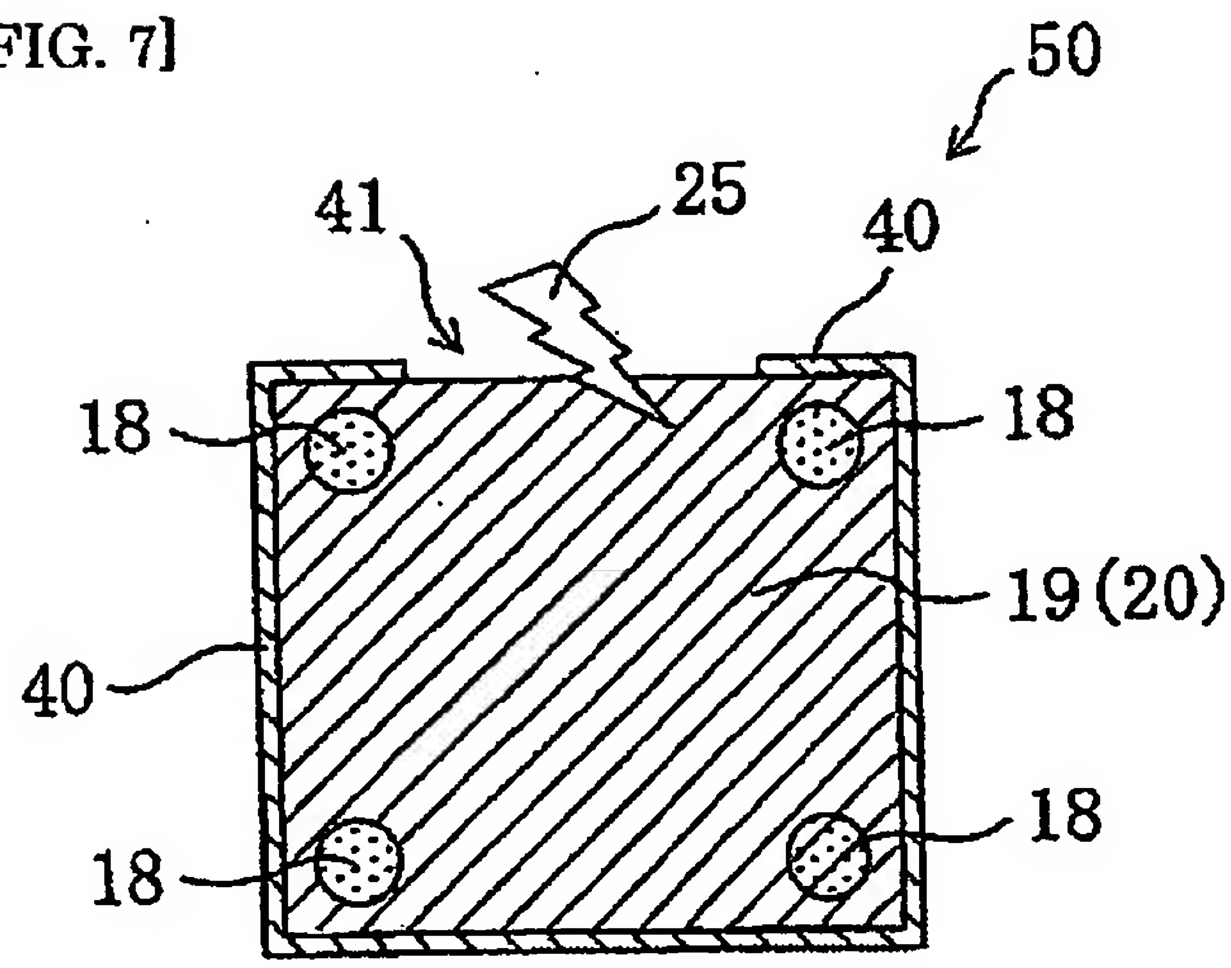
(a)


50
25
12 (10)
15
19 (20)
18
18

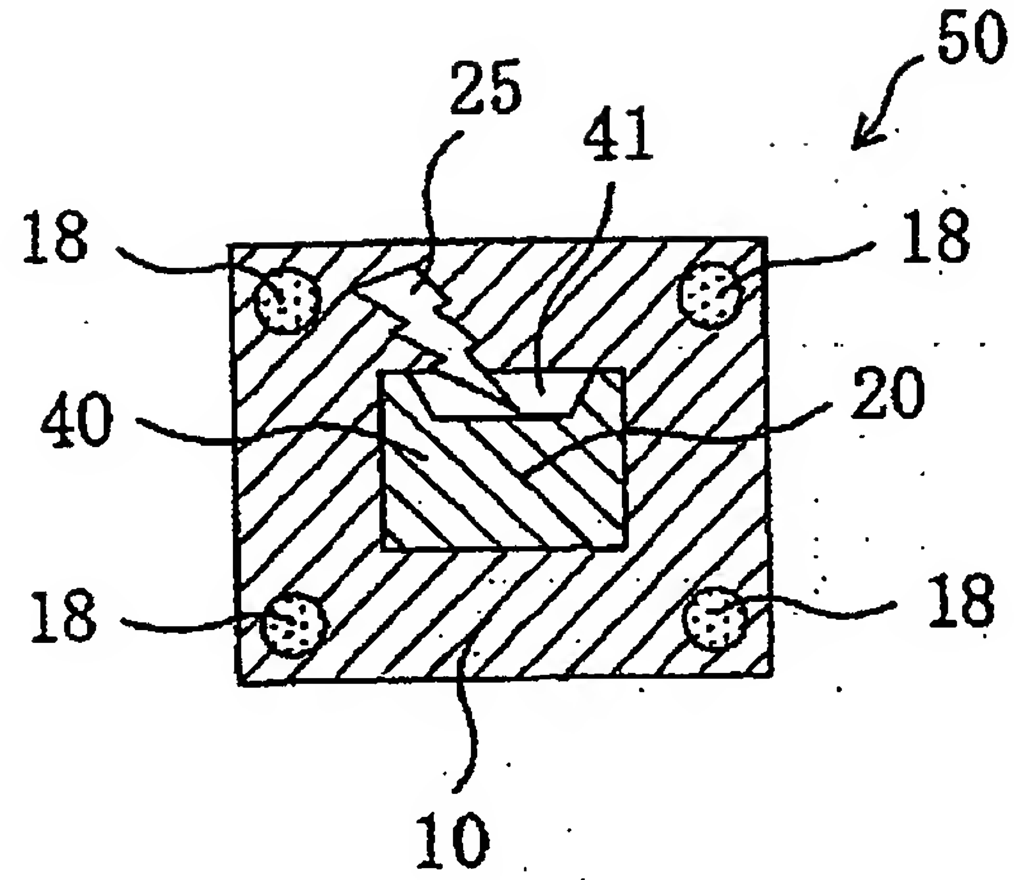
(b)


25
50
18
18
19 (20)
18
18

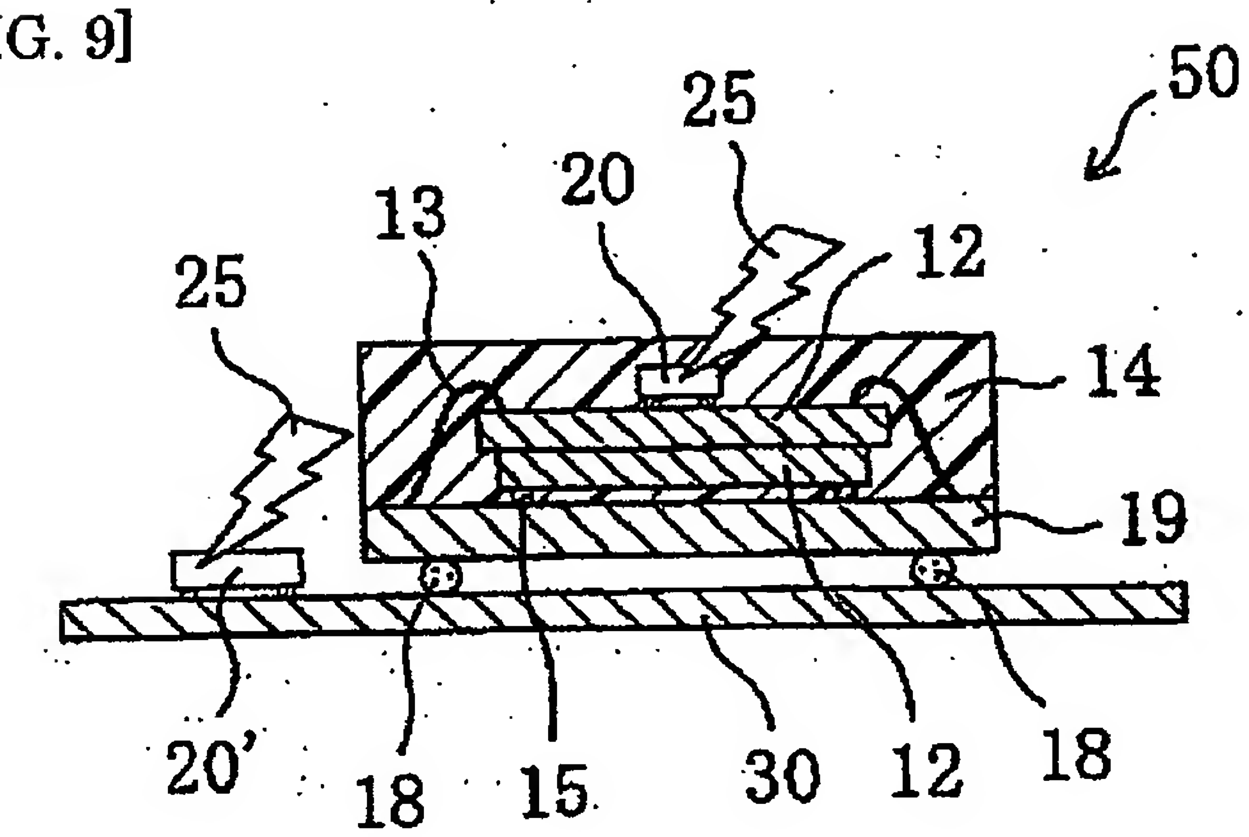
[FIG. 7]


50
41
25
40
18
18
19 (20)
40
18
18

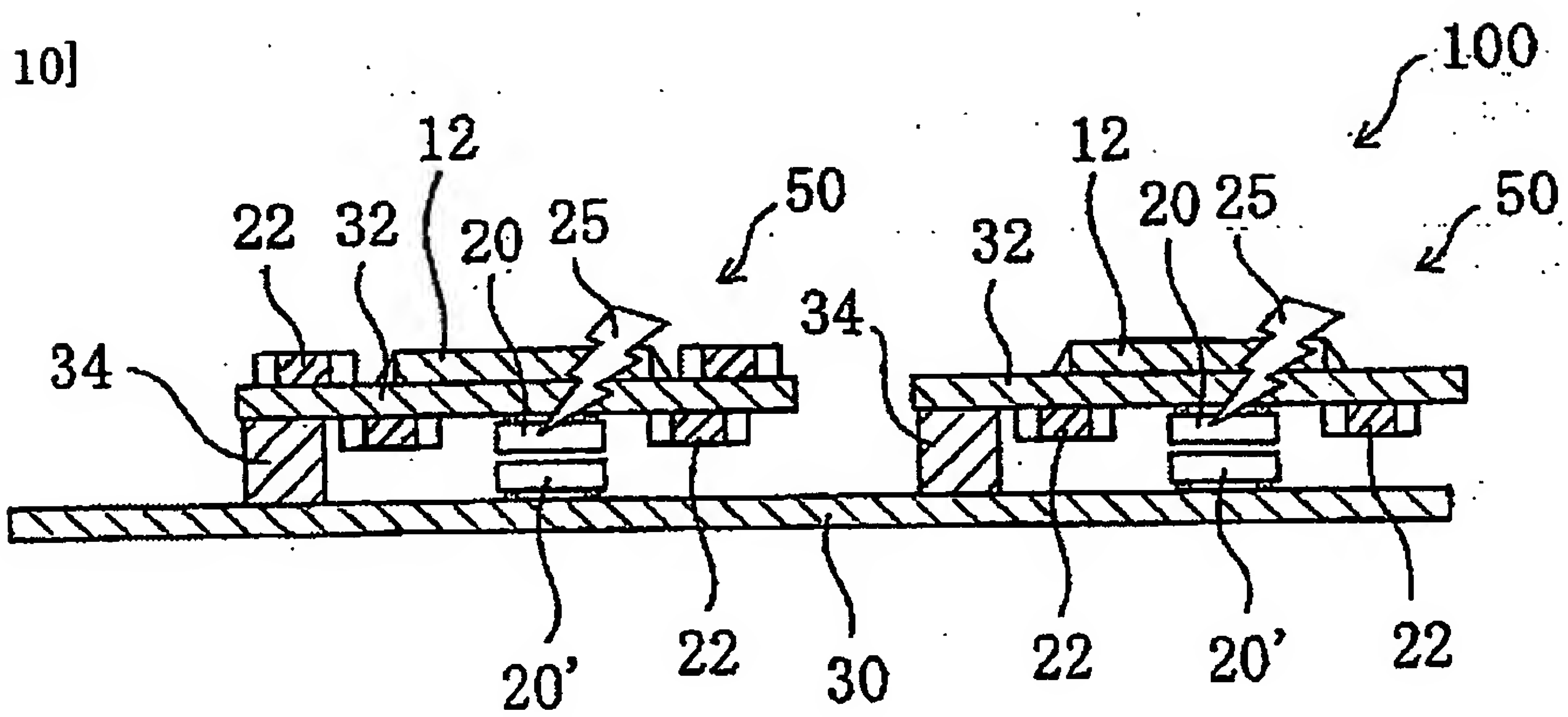
[FIG. 8]



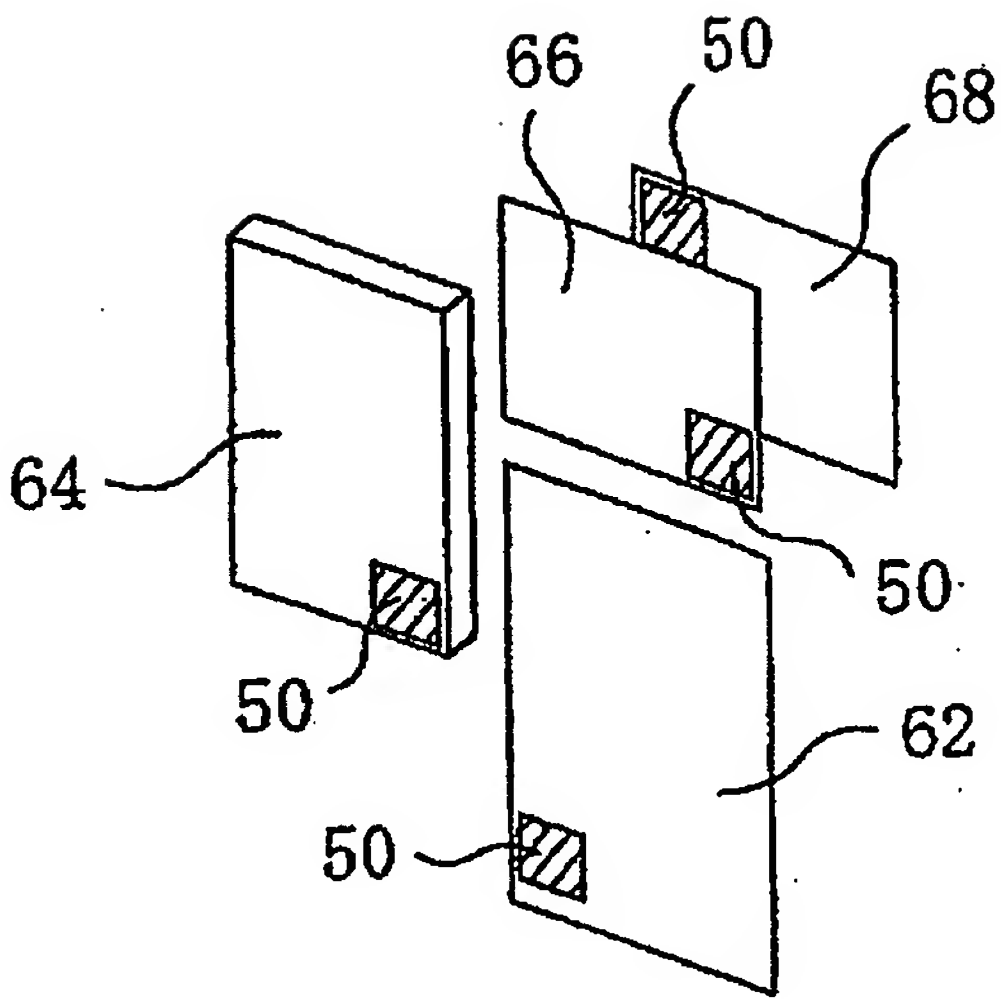
[FIG. 9]



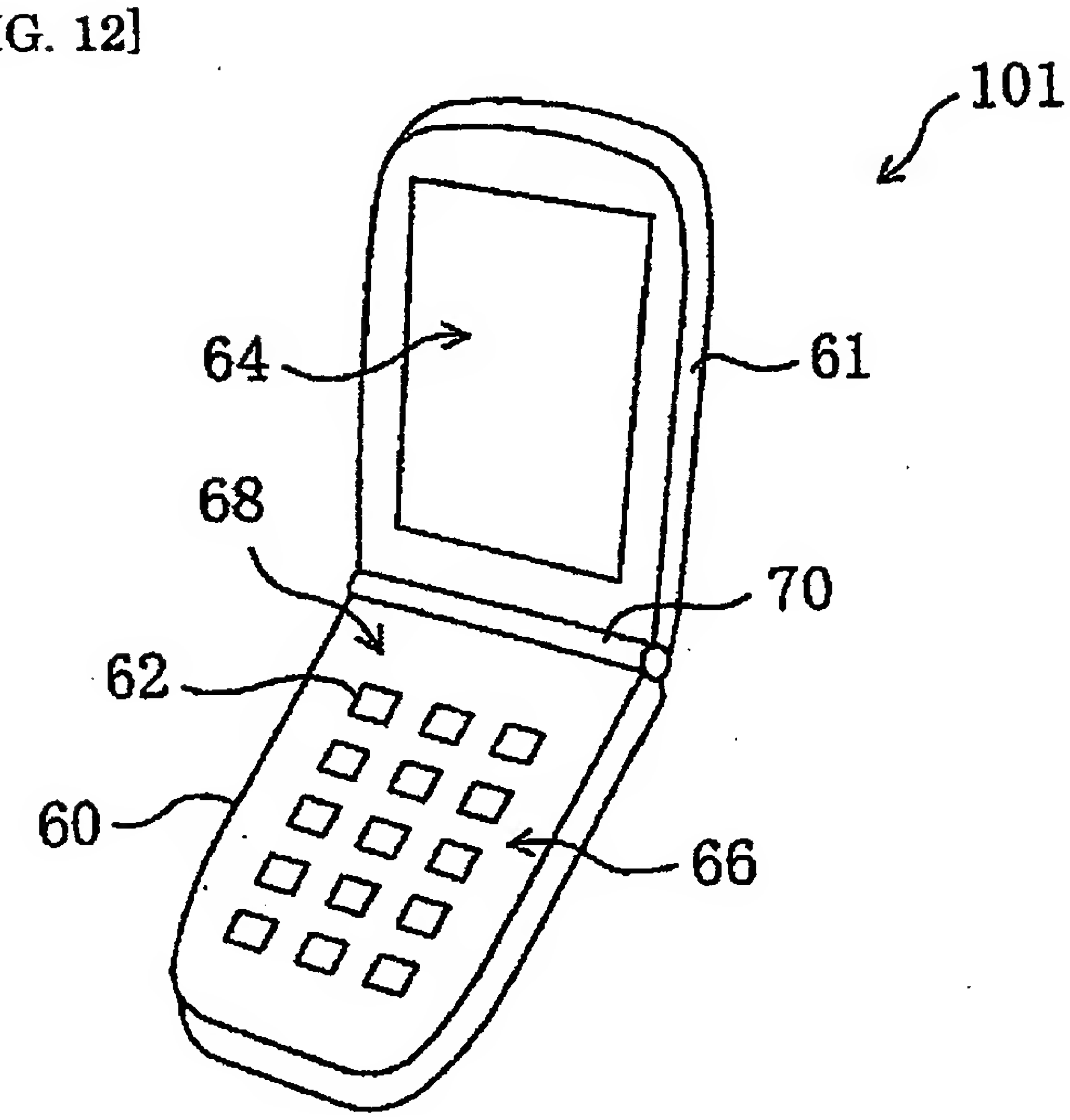
[FIG. 10]



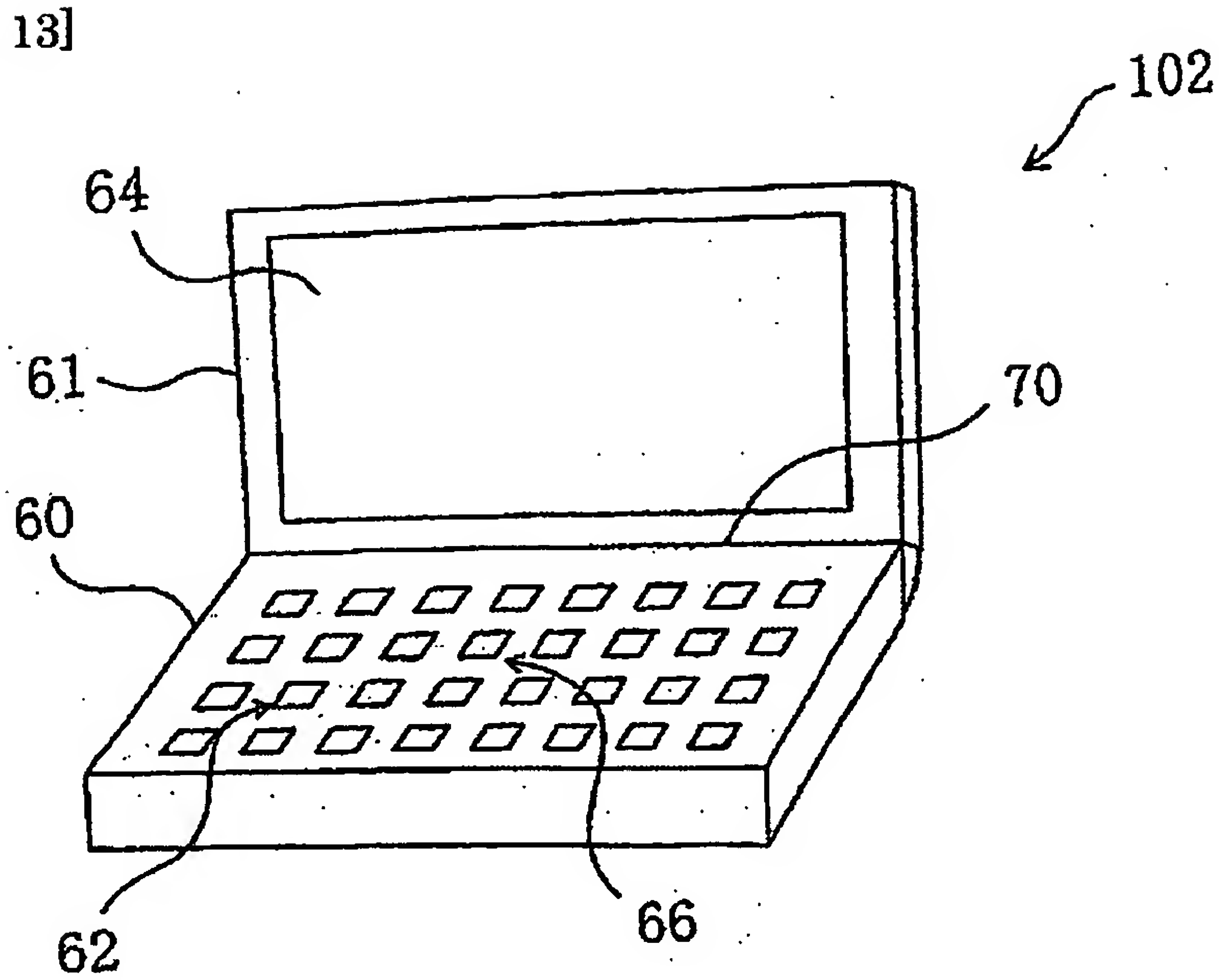
[FIG. 11]



[FIG. 12]



[FIG. 13]



[Document Name] ABSTRACT

[Abstract]

[Objective] To provide a module that allows the reduction of the number of wirings while being suitable for the miniaturization.

[Means for Solving the Problem] A module 100 that includes a plurality of semiconductor packages 50, each of the plurality of semiconductor packages 50 including an LSI chip (12) and a transmission and reception element 20 for conducting radio communication, constituted independently of the LSI chip (12). Furthermore, each of the plurality of semiconductor packages 50 in the module 100 transmits data with each other via a radio communication 25 conducted by the transmission and reception element 20 so as to operate cooperatively.

[Selected Figure] FIG. 3